

CLAIMS

WHAT IS CLAIMED IS:

- 1 1. An integrated circuit package comprising:
2 an integrated circuit die having an active surface; and
3 a cooling fluid in contact with the active surface.
- 1 2. The integrated circuit package of claim 1 further comprising:
2 an interposer coupled to the integrated circuit die.
- 1 3. The integrated circuit package of claim 2, wherein the interposer has a
2 microchannel surface that allows the cooling fluid to flow between the interposer and
3 the active surface of the integrated circuit die.
- 1 4. The integrated circuit package of claim 2 further comprising:
2 a package substrate, wherein a first side of the interposer is coupled to the
3 package substrate via solder bumps, and a second side of the interposer
4 is coupled to the integrated circuit die via solder bumps.
- 1 5. The integrated circuit package of claim 4 further comprising:
2 an underfill material disposed substantially between the interposer and the
3 package substrate.

1 7. The integrated circuit package of claim 1 further comprising:
2 a pump to circulate the cooling fluid.

1 8. A method of forming an integrated circuit package comprising:

2 attaching an interposer to a package substrate;

3 attaching an integrated circuit die to the interposer;

4 covering the package substrate, the integrated circuit die, and the interposer

5 with a heat spreader to form an internal chamber;

6 filling the internal chamber with a cooling fluid.

1 9. The method of claim 8, wherein the filling of the internal chamber is done by
2 pumping cooling fluid through a via in the package substrate.

1 10. The method of claim 9 further comprising:
2 sealing the via after the internal chamber is filled.

1 11. The method of claim 8, wherein the filling of the internal chamber is done by
2 pumping cooling fluid through an inlet, and sealing closed the inlet when the filling is
3 complete.

12. A method of cooling an integrated circuit die within an integrated circuit package comprising:

- providing power to the integrated circuit die; and
- moving a cooling fluid across an active surface of the integrated circuit die.

13. The method of claim 12, wherein the moving of the cooling fluid is performed by thermal convection.

14. The method of claim 12, wherein the moving of the cooling fluid is performed by a pump located inside of the integrated circuit package.

15. The method of claim 12, wherein the moving of the cooling fluid is performed by a pump located outside of the integrated circuit package.

16. The method of claim 12, wherein the cooling fluid changes phase by evaporating at a first location of the integrated circuit package and condensing at a second location of the integrated circuit package.

17. An integrated circuit package comprising:

- a package substrate;
- a first integrated circuit die having an active surface;

4 an interposer disposed between the package substrate and the first integrated
5 circuit die, the interposer establishing electrical connectivity between
6 the first integrated circuit die and the package substrate; and
7 a cooling fluid disposed between the first integrated circuit die and the
8 interposer.

1 18. The integrated circuit package of claim 17 further comprising:
2 a heat spreader covering the package substrate, the first integrated circuit
3 die, the cooling fluid, and the interposer.

1 19. The integrated circuit package of claim 18 further comprising:
2 a heat sink coupled to the heat spreader.

1 20. The integrated circuit package of claim 18, wherein the first integrated circuit
2 die has a microchannel surface in contact with the heat spreader, the microchannel
3 surface allowing cooling fluid to flow across the microchannel surface.

1 21. The integrated circuit package of claim 17, wherein the cooling fluid is in
2 contact with the active surface of the first integrated circuit die.

1 22. The integrated circuit package of claim 17, wherein the interposer provides
2 electrical functionality in addition to electrical connectivity.

1 23. The integrated circuit package of claim 22, wherein the interposer provides
2 capacitance.

1 24. The integrated circuit package of claim 22, wherein the interposer comprises a
2 second integrated circuit die.

1 25. The integrated circuit package of claim 24, wherein the second integrated
2 circuit provides an optical to electrical interface for the first integrated circuit die.

1 26. The integrated circuit package of claim 17, wherein the interposer has a
2 microchannel surface in contact with the active surface of the first integrated circuit die.

1 27. An integrated circuit package comprising:
2 a integrated circuit die housed within a chamber;
3 a cooling fluid filling the chamber and in contact with the integrated circuit
4 die.

1 28. The integrated circuit package of claim 27 further comprising:
2 a plurality of microchannels in a surface of the integrated circuit die.

1 29. The integrated circuit package of claim 28 further comprising:
2 a pump located within the integrated circuit package to pump the cooling
3 fluid through at least a portion of the plurality of microchannels.